Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

An Account of a new Method of ILLUMINATING *the* WIRES, *and* REGULATING *the* POSITION *of the* TRANSIT INSTRUMENT. *By the Rev.* HENRY USSHER, *D.D. S.F.T.C.D. M.R.I.A. and F.R.S.*

IT is now univerſally allowed that the paſſages of the celeſtial bodies over the meridian are more eaſily, more [*] abundantly, and more [†] accurately taken by means of the tranſit inſtrument, than by the method of equal altitudes.

EVERY attempt, therefore, to improve this valuable inſtrument is of importance; and as there are ſome particulars in the tranſit inſtrument of our obſervatory, which appear to me to be advantageous improvements, I conſider it my duty to lay them before the

---

[*] On account of the uncertainty of weather, which often prevents the correſpondent obſervation of altitude.

[†] On account of the variation of refraction at the given altitude, if the ſtate of the barometer or thermometer, or both, ſhould be different at the times of the two obſervations.

Academy: and in order to form a more juſt eſtimate of their value, I have given ſome ſketches of this inſtrument, as commonly executed, with a brief deſcription of the uſual modes of illuminating the wires, and ſubjoined the method adopted in that belonging to our obſervatory, with ſome other more important particulars.

Fig. I. Plate III. repreſents the inſtrument as commonly conſtructed, mounted ready for obſervation. The detail of the parts is unneceſſary, the inſtrument being in ſuch general uſe as to be known to every one. The candle or lamp for illuminating the wires by night is here made to deſcribe a circle equal and parallel to that deſcribed by the reflecting ſurface placed before the object glaſs, the centres of both lying in the ſame right line parallel to the horizon. This movement is effected by a ſimple apparatus repreſented in Fig. II.: it conſiſts of a ſtrong ring of wood, which ſurrounds the axis of the inſtrument at a ſmall diſtance, and is made faſt to the pillar; this ring ſupports and confines another, which has a liberty of circular movement, and carries the two arms A. B. one ſuſtaining a lantern, and the other a counterpoiſe; the lantern is loaded at the bottom, and plays freely upon a pin placed above its centre of gravity, and therefore always preſerves a vertical ſituation; it is ſo contrived as to let out the ſmoak at the back part, by which means the obſervations are leſs affected by the tremors ariſing from the vapour of the candle.

THERE is another method, very convenient for ſmall inſtruments, which I firſt ſaw at St. John's College, Cambridge; it is repreſented Fig. III. In this, the centre of motion of the arm which carries the counterpoiſe and lantern does not lie in the axis of the inſtrument, but at ſome diſtance above it, by which means the axis is diſengaged from ſurrounding wood-work, which is an obſtruction to the facility of reverſing the inſtrument for adjuſting or verifying the line of collimation; and that the light in the lantern may move in an arc equal and parallel to that deſcribed by the elliptic illuminator, the light muſt be as far diſtant from the point of ſuſpenſion of the lantern, as in the centre of motion of the arm above the axis; in this method, therefore, a lamp or a candle with a ſpring ſocket muſt be uſed.

In Fig. I. and III. the two ſpecies of elliptic illuminators, uſually applied, are repreſented; that in Fig. III. is an elliptic ring of paſteboard or other proper ſubſtance made white; the leſſer axis of the ellipſe is ſomewhat leſs than the diameter of the object glaſs,—the other ſhown in Fig. I. is a ſmall cylinder of ivory placed oppoſite the centre of the object glaſs: In each the ſurface is ſet in an angle of forty-five degrees to the axis of the teleſcope. Doctor Maſkelyne, whom I believe the inventor of the ſolid illuminator, has improved it lately, by ſubſtituting for the ivory ſurface a ſmall reflecting mirror, by which he obtains a ſufficient quantity of light for the wires, without ſo much loſs of the central rays.

In our tranſit inſtrument the entire light of the object glaſs is preſerved by a moſt ſimple contrivance:—That pivot of the axis which reſts upon the plate that regulates the motion in azimuth, is perforated with a ſmall hole, and in this is inſerted a convex lens; the plate and the pillar are perforated alſo in the direction of the axis; the perforation in the pillar near the back part is three inches in diameter; in this is inſerted a tube carrying another larger convex lens; to this tube is attached the lantern, in which the flame of the candle is kept always oppoſite the axis of the tube by means of a ſpring ſocket.

THE rays of light iſſuing from the candle are by theſe lenſes brought to a focus immediately beyond the ſmall lens inſerted in the pivot, and diverging from thence, within the conical axis, are intercepted at the ſquare box in the centre by a diagonal plate of ſilvered braſs, which reflects the light down to the wires; this plate is perforated with an elliptical hole, to let the cone of rays from the object glaſs paſs through undiminiſhed. See Fig. IV.

To temper this light in proportion to the ſtar obſerved, there is a green glaſs increaſing gradually in depth of tint from the top to the bottom: this glaſs is ſet in a braſs frame, which ſlides in a dovetail between the azimuth plate and the pillar; and the elevation or depreſſion of this is regulated by a lever, the arm of which is readily brought to the hand in any poſition; this lever conſiſts of two ſeparate arms, which are preſſed together by ſcrews, and each turn upon one pin inſerted into the pillar: by lightening the ſcrews the friction of the arms againſt each other may be ſo increaſed, that when the longer arm is moved the ſhorter one moves with it, and raiſes or lets down the glaſs-frame; when this is raiſed to the greateſt height, then the ſhort arm preſſes againſt the bottom of the azimuth plate, and any additional force now applied overcomes the friction at the centre; ſhould the motion of the arm be required in the oppoſite direction, this is effected by making the ſhort arm preſs againſt a pin placed below it, with a ſimilar effect to the former, the force applied overcoming the central friction as above; and thus the long arm may be brought parallel to the teleſcope in whatever poſition it is ſet for obſervation.

FIG. V. repreſents the lever and glaſs-frame; the azimuth plate is repreſented by dotted lines. If it be required to move the long arm from the poſition there repreſented to a vertical ſituation for an obſervation in the zenith; then by depreſſing the handle x, the ſhort arm a, a is raiſed and puſhes up the glaſs-frame, until a, a preſſes againſt the bottom of the azimuth plate, where, as it can go no higher, any additional force in that direction overcomes the friction at the central pin (d) and the long arm is readily brought into a vertical poſition, the ſhort one remaining at the azimuth plate; and in this new poſition, the lever has the ſame power of regulating the deſcent of the frame as before: if it be required to put the arm into an horizontal poſition, the preſſure of the ſhort arm againſt the pin (p) inſerted in the pillar below it, overcomes the central friction in this direction; h repreſents the hole in the pillar through which the light comes; n, n the braſs frame; b, b the green glaſs.

IN juſtice to Mr. Ramſden I muſt obſerve, that it was not without ſome difficulty that I prevailed upon him to introduce this mode of illumination in this inſtrument, he being juſtly cautious leſt the heat of the candle might have any effect on the axis; but ſeveral hours carefully employed by him and me in critical experiments, ſatisfied him fully that his fears were groundleſs, and I can now by experience of the inſtrument pronounce them ſo.

THIS mode of illumination has many advantages. Firſt, the object is not rendered tremulous by the vapor and flame of the candle decompoſing the air at the object glaſs. Secondly, no part of the light afforded by the object glaſs is loſt. Thirdly, you can diminiſh your aperture at pleaſure without the trouble of altering your illuminator; whereas if the annular one be applied a different elliptic ring muſt be provided for every diminution of aperture; if the ſolid illuminator be uſed, you cannot diminiſh the aperture very much, and preſerve the valuable central rays *. Another uſe of this method has occurred to me ſince I began to apply it, which is this—by accurately dividing the ſtem of the glaſs-frame, and removing the green glaſs, we might more certainly determine the different magnitude of the ſtars, by noting the quantity of light neceſſary to efface them.

I NOW come to the principal improvement in this inſtrument; an invention that does high honour to Mr. Ramſden, and is a moſt valuable acquiſition to all aſtronomical inſtruments where plumb lines are introduced.

---

* The advantages of a great diminution of aperture on particular occaſions I ſhall mention in a future paper.

The Method of adjuſting the horizontal Poſition of the Axis.

EVERY one muſt allow, that the adjuſtment by the ſpirit level is of all modes the moſt convenient, but it is not without its defects; there are few levels true to leſs than two ſeconds in winter, when all levels are moſt ſluggiſh; add to this, that the pivots of the axis muſt, for this adjuſtment, be accurately of equal diameters, and perfect cylinders; we muſt alſo take into account the danger of any partial heat reaching the glaſs tube, which will create an enormous error.

To remedy theſe defects, a plumb-line has been ſubſtituted, but generally not well contrived. The uſual adjuſtment by the plumb-line has been, to attach two ſmall pins to the tube of the teleſcope, one near the object glaſs, the other near the eye end of the tube, and to make a plumb-line, ſuſpended from one of theſe, paſs over and biſect two fine points, one near each end of the tube; then, inverting the teleſcope, and ſuſpending the plumb-line from the other pin, to ſee whether it biſect the ſame points again; and if not, to correct half the error in the uſual manner: but this appears to be dangerous to the line of collimation.

MY firſt attempt at adjuſtment by the plumb-line in the year 1774, was to ſuſpend a braſs rod by hooks on the pivots, like the horizontal bar of a level, and to the middle of this I attached a vertical bar with two fine points, and a plumb-line; but this was ſubject to inaccuracy, unleſs the pivots were preciſely of equal diameters. I then contrived that the bar ſhould not hook on the pivots, but be preſſed upwards by a ſpring againſt their under parts. Fig. VI. ſhews the principle of this adjuſtment. A is the extremity of the pivot of the axis; c the ſpring, which is attached to the notched piece n, n, reſting on the pivot, and forcing the piece T, T upwards, which raiſes the whole adjuſting tool, and keeps the notch l, l, bearing againſt the lower part of the pivot; l, l, m, m is a piece ſimilar to the vertical bar of a level ſeen in profile; o, o is the profile of the perpendicular bar which ſtrengthens the horizontal bar; to the middle of this is attached the vertical bar y, y, with two fine points, one being moveable; beſide this hangs the plumb-line x, x, with the plummet P ſwinging in water.

ALTHOUGH this adjuſtment was independent of all inequality in the pivots, yet it was objectionable, becauſe during the adjuſtment there was the weight of the tool on the axis, from which it was diſengaged in the act of obſervation; whence the inſtrument was proved and applied in diſſimilar circumſtances. But whilſt I had this tool actually in hands, the following elegant and unobjectionable mode was deviſed by Mr. Ramſden, which immediately made me lay aſide all thoughts of the former; and in fact I know of no late invention that ſeems to promiſe more towards the improvement of all aſtronomical inſtruments where plumb-lines are applied.

IN one ſide of the tube of the teleſcope, and twelve inches from each end of it, he makes a ſmall hole, and inſerts a very thin ſemipellucid bit of ivory, with a black dot in the centre;

in the other ſide of the tube, oppoſite to each of theſe, he inſerts a convex lens; now it is obvious that an image of each dot will be formed in the conjugate focus of its correſponding lens. The tops of the pillars ſupport a braſs frame, carrying a plumb-line and two microſcopes, placed directly before the images of the dots, to which their foci are adjuſted, ſo that the images are diſtinct and magnified; and the plumb-line being moveable by ſcrews at the ſuſpenſion frame above, is made to ſwing through theſe images. Nothing can be better imagined than this.

In the firſt place, the adjuſtment is applied totally independent of the inſtrument; and ſecondly, the plumb-line hanging in the images themſelves, there cannot poſſibly be any parallax on the wire, nor any corpuſcular attraction exerted on it, as is probably the caſe when a plumb-line is brought very near to a metallic plate; inconveniences to which all plumb-lines have hitherto been in ſome degree ſubject.

The three plates are deſigned to ſhew this valuable adjuſtment more fully.

Plate II. Fig. I. is a bird's-eye view of the top of the eaſtern pillar. Fig. II. of the weſtern.

On the top of each pillar, and in the direction of the meridian, is ſhewn a priſmatic bar of braſs, A, B, ſeen in profile, and of a larger ſize in Fig. III. The horizontal poſition of this bar is obtained by the capſtan headed ſcrew t, and is fixed by the other capſtan head T; the application of the other capſtan headed ſcrew D, with its ſetting ſcrew, will be ſhewn in the application of the adjuſting tool.

On the top of each pillar is a braſs cock marked C, and ſeen in profile, and of a larger ſize in Fig. IV.; in this the ſcrew X works vertically, and is ſet by the ſcrew Y.

E G F H I is a frame covered with green ſilk to ſcreen the axis from the ſun*. K, K are holes in the ſilk to let the hooks of the counterpoiſes through, to relieve the Y plates from the entire weight of the inſtrument.

Plate III. Fig. I. ſhews the adjuſting tool, the notches N, N, cut in the end of the horizontal arm, reſt upon the priſmatic bar ſhewn in the former figure, and the extremity Z, of the horizontal bar at right angles to this, reſts upon the point of the vertical ſcrew, which works in the cock C, on the oppoſite pillar. C, P is a fine ſilver wire, ſupporting the plummet P, which ſwings in a glaſs veſſel filled with water, as is uſually done to check the vibration. X, X are the two microſcopes, into the focus of which the wire is brought by the ſcrew C, ſhewn more diſtinctly in Fig. II. in which D is the head of a ſmall ſcrew, which confines the end of the plumb-line under its ſhoulder, the plumb-line hangs through the hole H, and reſts in a fine notch cut in the chamfered edge S, S. The ſcrew B draws the whole ſyſtem L M N R eaſt or weſt, to draw

the wire oppoſite the dot; and its poſition is ſecured by a ſpring concealed in the tube A. The ſcrew C, as mentioned before, moves the frame a b c d north or ſouth, and its place is ſecured by a ſpring ſhewn in the figure. W is a pinion which works in a rack that ſupports the glaſs veſſel filled with water; by means of this the veſſel can be raiſed ſo as to relieve the wire from the weight of the plummet when the machine is moved.

---

* The view of the counterpoiſes is here omitted, not to embarraſs the figure.

PLATE IV. Fig. I. ſhews a ſkeleton of the adjuſting tool on its ſupports, and parallel to the teleſcope B B, which during the adjuſtment is always in a vertical poſition.

FIG. II. is the ſame in profile. Q, Q are the dots; o, o the lenſes, by means of which the images of the dots are formed in the conjugate foci at S, S; theſe images are diſtinctly ſhewn by the microſcopes x, z; the plumb-line is made to ſwing through one dot by means of the ſcrews at the top of the adjuſting tool already ſhewn in Plate III. Fig. II.; whilſt the other dot, which is moveable from right to left, has its image brought to the wire by means of a ſcrew S in Fig. III. Plate III. which repreſents the piece which carries the moveable dot. We now ſuppoſe that the plumb-line ſwings through the centre of each image, and the true poſition of the tool is ſo far obtained, provided the plummet hangs freely in the middle of the glaſs veſſel, which will be the caſe when the arm, which reſts upon the priſmatic bar, that is, when the bar itſelf is horizontal; this is obtained by the capſtan headed ſcrews t, T, Fig. III. Plate II. Provided alſo that the other arm C, L, is truly horizontal, which poſition is obtained by the ſcrew, which works vertically in the cock C, Plate IV. Fig. I. and Plate II. Fig. IV.

THE juſt diſtance of the tool from the teleſcope is ſhewn by the diſtinct viſion of the images; and in order to obtain the ſame diſtance exactly at all times, the ſcrew D, in Fig. III. Plate II. is moved, 'till its point juſt preſſes againſt the end of the notched piece which reſts on the bar, and is there ſet by the ſcrew S *(ſame figure)*. Let now the ſcrew W at the bottom be turned, ſo as to relieve the plumb-line, and let the tool be removed; then let the teleſcope be inverted, and the tool brought to the other ſide, and placed upon the other bar and cock, let the wire be made to ſwing through and biſect the upper image; if now the teleſcope has turned upon an axis truly horizontal, the plumb-line will alſo biſect the lower image; if not, correct half the error as uſual, and repeat the adjuſtment 'till all error vaniſhes.

THUS we ſhall have the inſtrument proved, without any additional weight on the axis; we have the advantage of a long plumb-line, without parallax, or corpuſcular attraction; and all error of the artiſt in the diameters of the pivots is rendered of no conſequence whatever.

Apparatus for reverſing the Inſtrument.

As the line of collimation requires conſtant verification, the reverſing of the axis ſhould be rendered as commodious as poſſible; particularly as this is always done to the greateſt nicety by celeſtial obſervations, which will not admit of delay. I always prove it by the polar ſtar*, and this is the method: I obſerve the paſſages over the three firſt wires; I then reverſe the inſtrument, and take the paſſages over the two laſt wires, that is, in fact over the two firſt again. Now it is manifeſt, that if the collimation be perfect, the intervals from the firſt wire to the middle one, and from the middle one to the fifth, will be preciſely equal, as alſo the intervals from the ſecond to the middle, and from the middle to the fourth. The apparatus for this purpoſe, ſhewn in Plate V. Fig. I. is ſo manageable, that I can reverſe this weighty inſtrument without help in the ſhort half paſſage of ß Urſæ minoris, in time to obſerve the paſſage over the laſt wire, having before reverſing obſerved the paſſages over the firſt, ſecond and middle wires. The horns E, E, being placed under the axis: the winch A is turned, which works with a double pinion in the rack B, which is double, having the teeth ſet at alternate intervals, as ſhewn in Fig. II. by which means the ſmootheſt motion poſſible is obtained: this rack elevates the block C, hollowed conically to receive the extremity of the cylinder D, made to fit it; and this raiſing the upper work on which the axis now reſts, lifts the inſtrument off its ſupports, which is then readily turned round on the cylinder D, working in the cone C and female cylinder F, F; and may be then, in its reverſed poſition, ſmoothly and gently lowered down again to its ſupports.

---

* The reaſon why I prefer the polar ſtar is, becauſe the ſmalleſt error in the collimation will, on account of the ſlow motion of this ſtar, ſhew a difference which cannot be attributed to the unavoidable error of obſervation, or caſual irregularity of the clock; at leaſt we know the limit by practice.